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[Title Of The Invention]
STRUCTURE FOR JOINING EXTERNAL METAL TERMINAL TO CERAMIC SUBSTRATE

[Abstract]
PURPOSE: To improve reliability of joining and yield of joined body by joining one end face of external metal terminal through a silver-copper-based solder material to a pad part of a ceramic substrate consisting essentially of mullite.
CONSTITUTION: A pad part 3 consisting of a metallized face and satisfying the formula (D-d)/2-X=0.25mm wherein D is diameter of joining face of the pad part; d is diameter of one end face of external metal terminal; X is distance from the center of joined face of the pad part to the center of one end face of the external metal terminal is formed on the surface of a ceramic substrate 2 consisting essentially of mullite and simultaneously, a part of the pad part 3 except most part thereof is covered with an insulating film 5 which is homogeneous to the ceramic substrate. Then, one end face of the external metal terminal is joined through a silver-copper solder material 6 to this pad part 3.

[Claim(s)]
[Claim 1]In what joined an end surface of an external metal terminal to a pad section of a ceramics board in silver copper (Ag-Cu) system wax material, When setting [a diameter of a plane of composition of a pad section] distance from the center of said plane of composition of d and a pad section to the center of said end surface to X for a diameter of said end surface of D and an external metal terminal, Joining structure of a ceramics board and an external metal terminal which the main ingredients of a ceramics board are mullite and are characterized by having satisfied the following conditions.
(D-d) /2-X >=0.25mm

[Detailed Description of the Invention]
[0001]
[Industrial Application]In this invention, it is related with the joining structure of a ceramics board and an external metal terminal.
Therefore, the soldering pad and input/output terminal members, such as a lead and a pin, which were formed especially in the multilayer interconnection board may be used suitably for the pin grid array IC package joined in wax material.
[0002]
[Description of the Prior Art]High-density IC packages, such as a pin grid array (PGA), It comprises a multilayer interconnection board provided with the pad section which arranged a large number in all directions, and was formed on the principal surface while carrying integrated circuit IC, and external-terminal-parts material, such as an I/O (input and output) pin which consists of covar etc. of a large number joined to the pad section of this multilayer interconnection board.
The frame for closure which becomes an edge part of IC mount part of the multilayer interconnection board from covar etc. further by a case is joined.
[0003]The multilayer interconnection board consisted of ceramics which usually use alumina etc. as the main ingredients, and is provided with the insulating layer of two or more sheets of plate shape, and the various circuit patterns formed in the main table side of each insulating layer with the refractory metal. External metal terminals, such as an output pin, are making the nail (nail) shape in which the collar-like part of the larger diameter was provided at the tip of idiosoma of about 0.3-0.4 mm in diameter round bar shape, for example.

The collar-like part is made into the plane of composition.
And it is requested in very many cases that the bonding strength of ceramics and an external metal terminal should exceed the intensity of the external metal terminal itself for reliability reservation of a ceramics section.
[0004]
[Problem(s) to be Solved by the Invention]By the way, for making signal propagation speed quick in recent years and preventing beforehand the faulty connection of integrated circuit IC, and exfoliation, As an insulating layer in the multilayer substrate of the above high-density IC packages, the proposal which is going to use the nature ceramics of mullite is made (JP,57-23672,B, JP,55-139709,A).
[0005]That is, since the propagation-delay time of an electrical signal is proportional to the square root of the dielectric constant of the insulating layer which surround a wiring conductor, it tends to attain improvement in the speed of the signal for mullite with small specific inductive capacity as the main ingredients of an insulating layer. Since the coefficient of thermal expansion of silicon is $3.5x10^{-6}$/** in the case of what integrated circuit IC becomes from semiconductor silicon, it is going to reduce the heat stress of IC connection section by using small mullite of this and thermal expansion difference as the main ingredients of the insulating layer of IC mount part.
[0006]However, when the thing of the structure which joined the external metal terminal to the multilayer interconnection board which consists of a nature sintered compact of mullite in the same way as receiving the conventional alumina substrate was applied to the tensile strength examination, the case where it destroyed in a ceramics section with low strength arose frequently. Therefore, the yield was worsened while the reliability of the whole package was missing.
[0007]The 1st purpose of this invention solves the above-mentioned conventional technical problem, and there is in providing the joining structure of the nature ceramics board of mullite and an external metal terminal excellent in the reliability of junction. The 2nd purpose is to raise the yield of a zygote.
[0008]
[Means for Solving the Problem]In that from which this invention joining structure joined an end surface of an external metal terminal to a pad section of a ceramics board in silver copper (Ag-Cu) system wax material for the above-mentioned purpose achievement, When setting [a diameter of a plane of composition of a pad section] distance from the center of said plane of composition of d and a pad section to the center of said end surface to X for a diameter of said end surface of D and an external metal terminal, the main ingredients of a ceramics board are mullite and have satisfied the following conditions.
[0009](D-d) -- /-- 2-X>=0.25 mm, the center of a plane of composition of a pad section means the center of the whole field here, while a whole surface product of a pad section gets wet in wax material and is participating in junction. Since the periphery is covered with an insulating material, when wax material does not get wet in a coating part, a thing of the center of a field except a coating part is said. And the left side of the above-mentioned inequality shows minimum width of a meniscus portion formed of wax material between a pad section and an external metal terminal.
[0010]
[Function and Effect]At the time of soldering, it becomes the conical shape which the wax material overflowing from the connecting end face of the external metal terminal dwindles toward the method of outside as the longitudinal plane shape is shown in drawing 1. The surface which curved to this conical shape is meniscus. And the width of meniscus is set to constant value (D-d)/2 when the center of the plane of composition of a pad section and the center of the end face of a metal terminal are in agreement (X= 0).
[0011]However, the width of the meniscus at the time of X!=0 serves as the minimum [(D-d) /2-X] by the side from which the position of the metal terminal shifted, and serves as the maximum [(D-d) /2+X] in the opposite hand. And if a tensile stress is applied to a soldering portion, a pad can be scooped out of the weak place of adhesive strength.
[0012]Then, when the main ingredients of a ceramics board were mullite variously as a

result of an experiment and the minimum width of the meniscus portion formed of wax material was smaller than 0.25 mm, even if it obtained with the area of the pad and was large, it turned out with low tensile strength that a pad can be scooped out. Therefore, it depends for the bonding strength of a soldering portion on the minimum of meniscus width.

[0013]Since the intensity of an alumina sintered body is high when a ceramics board mainly consists of alumina, even if the stress by thermal expansion difference occurs in a joined part with an external metal terminal, destruction of a ceramics board does not take place easily. Therefore, it is not necessary to take meniscus width into consideration on the usual manufacturing conditions.

[0014]On the other hand, a mullite sintered compact has intensity weaker than an alumina sintered body. In addition, thermal expansion difference with an external metal terminal is also larger than the case of an alumina sintered body. Therefore, since it is easy to destroy in a soldering portion, it is thought that different consideration from alumina is required.

[0015]The presentation of silver copper (Ag-Cu) system wax material has that good to which an Ag/Cu weight ratio belongs to the range of 50 / 50 - 87/13. It is because liquid phase temperature becomes high, it must solder at a temperature higher than 900 ** and workability worsens, even if there is more Ag at least than this range. Silver copper (Ag-Cu) system wax material may contain a little third ingredient other than AgCu, for example like the indium In, unless it deviates from the characteristic.

[0016]If the periphery of the pad section is covered with the insulating material, the flow of the wax material to a pad section peripheral edge will be dammed up. As a result, the further stress concentration to the pad section peripheral edge which stress tends to concentrate can be suppressed, and destruction of a terminal area can be prevented. Therefore, it is desirable to cover the periphery of a pad section with the insulating material.

[0017]

[Example]

[This invention joining structure] One example of this invention joining structure is described with a drawing. Drawing 1 is a sectional view showing the joined part of a ceramics board and a nail pin provided with this invention joining structure.

[0018]The joining structure 1 comprises the ceramics board 2 of 75 % of the weight of mullites, and density [of 2.9g/cm] ^{3}, the pad 3 which consists of a metalization side formed in the surface of this ceramics board 2, and the nail pin 4 joined to the pad 3. And except for most pads 3, the surface of the ceramics board 2 is homogeneous as the ceramics board 2, and is covered with the 15-micrometer-thick insulator layer 5.

[0019]The pad 3 is the two-layer structure (however, as for directly under [of the insulator layer 5], the 2nd layer does not exist.) of the 2nd layer which consists of the 1st layer and 2-micrometer-thick nickel which consist of 20-micrometer-thick tungsten, and serves as a size 1.55-2.05 mm in diameter.

Since 0.15 mm of the periphery is covered with the insulator layer 5, the size of the portion which is participating in junction at the nail pin 4 is 1.4-1.9 mm in diameter.

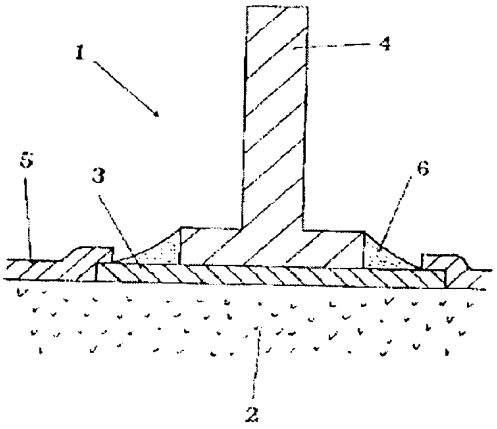
[0020]The nail pin 4 is an external metal terminal used for this invention joining structure. By the 4.5 mm [in overall length] product made from covar (KOVAR), it becomes idiosoma 0.45 mm in diameter, and its end from the collar-like part (0.7 mm in diameter, and 0.3 mm in thickness) which stands in a row in one.

The pad 3 and the nail pin 4 are joined with the silver-copper wax (85 % of the weight of Ag) 6 of the specified quantity. 42 alloys and the alloy 194 (Cu alloy) may be sufficient as the construction material of the nail pin 4.

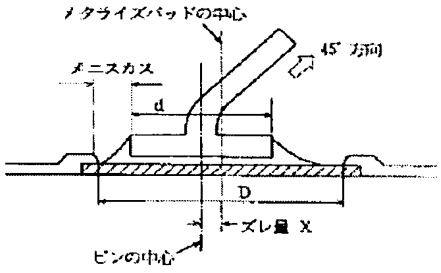
[0021][Manufacturing method of the zygote provided with this invention joining structure] The manufacturing method of such a zygote is explained. First, the paste of the tungsten W is screen-stenciled to a prescribed pattern, and the pattern of each pad is formed in the surface of the green sheet which uses ceramics powder, such as mullite, as the main ingredients. Next, the insulating paste which uses ceramics powder of the same

presentation as the main ingredients is printed on the surface of a green sheet. And these green sheets are calcinated at an around 1500 degrees C elevated temperature, nickel plating is given, and it becomes the ceramics board 2.
[0022]Separately, said nail pin 4 is prepared and the 0.3-mg Ag-Cu wax 6 is attached to the collar-like part end face. The nail pin 4 is joined to the pad 3 of said ceramics board 2 in the furnace preset temperature of 900 degrees C, and nitrogen-hydrogen mixed gas with the Ag-Cu wax 6. The joining structure 1 is completed now.
[0023][An experiment and evaluation] In the above-mentioned joining structure 1, the size and shape of the nail pin 4 were made into constant value, about what changed various area of the pad 3 which participates in junction, the free end part of the nail pin 4 was pulled in the direction of 45 degree, as shown in drawing 2, and while measuring bonding strength, destructive mode was observed. The RBI of the relation between the distance X (horizontal axis) of position shifts from the center of the pad 3 to the center of the nail pin 4, i.e., the amount, and bonding strength (vertical axis) was carried out to drawing 3.
[0024]Although the amount of position shifts shows the bonding strength which was stabilized as for constant value in each pad surface product from this figure, it turns out that bonding strength falls as the amount of position shifts will become large, if constant value is exceeded. Although similarly measured about that whose diameter of the pad 3 is 1.9 mm, since the same tendency was shown, the RBI was omitted. Furthermore, to a millimeter order, the diameter of the collar-like part end face of D and the nail pin 4 was set to d, the amount of position shifts was set to X for the diameter of the plane of composition of the pad 3, the RBI of the relation between the minimum [(D-d) /2-X] of meniscus width and bonding strength was carried out, and it was shown in drawing 4.
[0025]This figure showed that bonding strength was always set to 5 or more kgf when the minimum of meniscus width is 0.25 mm or more irrespective of the diameter of the pad 3. And bonding strength 5kgf is equivalent to the mechanical strength required of the nail pin itself. Therefore, it becomes possible to manufacture an IC package with stably high bonding strength by setting a pad diameter, a nail pin diameter, a dimensional tolerance, and jig common difference that the minimum of meniscus width is set to 0.25 mm in the stage of designing a product. In the quality inspection process of a product, supply of a defecting-joining article can be beforehand prevented by inspecting the minimum of meniscus width.
[0026]
[Effect of the Invention]Since the joining structure of the mullite ceramics board of this invention and an external metal terminal is provided with the above composition, it is excellent in the reliability of junction and, moreover, is high. [of a production yield] Therefore, signal propagation speed is quick, it is stabilized and the IC package excellent in connectivity with IC can be supplied.
[Brief Description of the Drawings]
[Drawing 1]It is an important section sectional view showing the joining structure of a ceramics board and an external metal terminal.
[Drawing 2]It is a figure explaining how to measure bonding strength.
[Drawing 3]It is the graph which carried out the RBI of the bonding strength to the amount X of position shifts.
[Drawing 4]It is the graph which carried out the RBI of the bonding strength to the minimum [(D-d) /2-X] of the amount of meniscuses.
[Description of Notations]
1 Joining structure
2 Ceramics board
3 Pad
4 Nail pin (external metal terminal member)

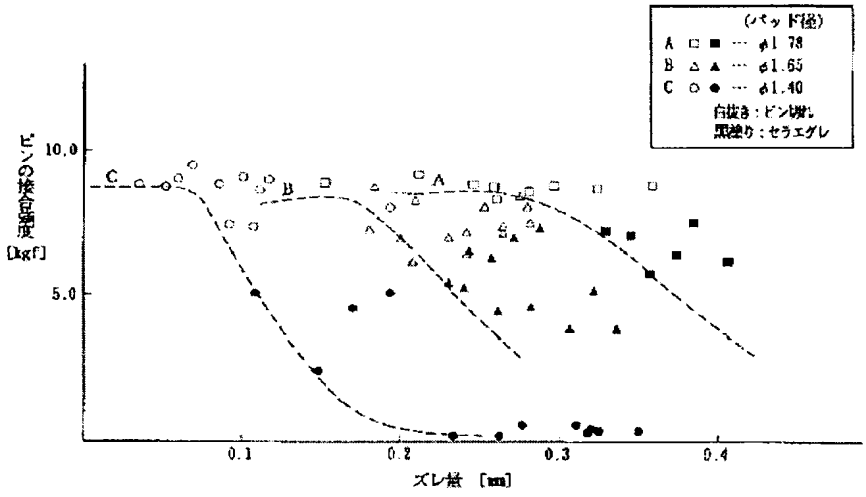
【図１】


1
2
3
4
5
6

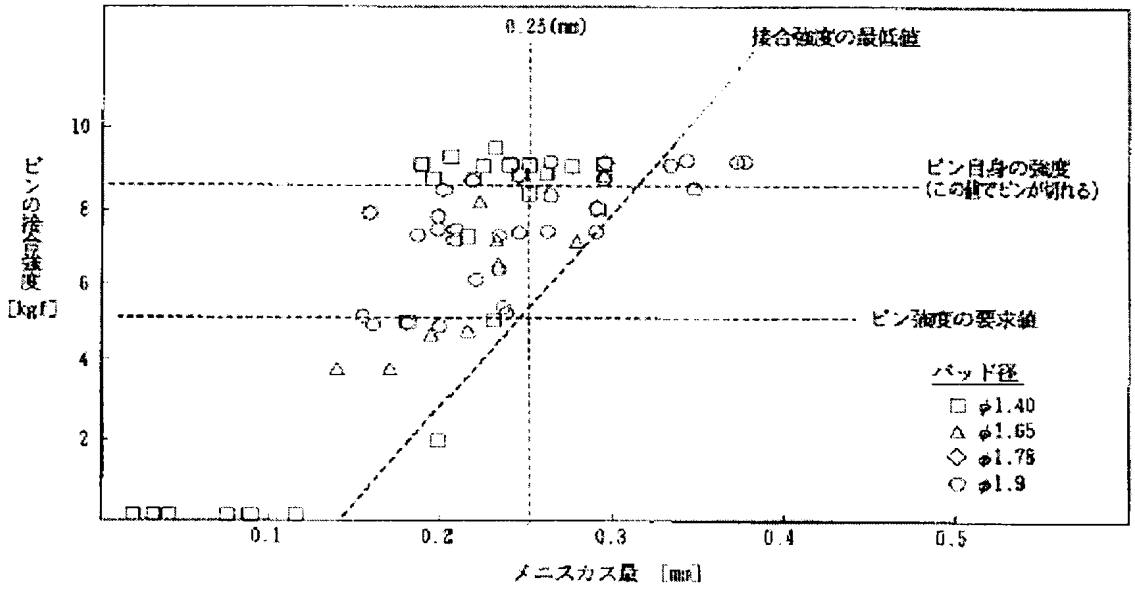
【図２】


メタライズパッドの中心
45° 方向
メニスカス
d
D
ズレ量 X
ピンの中心

【図３】


(パッド径)
A □ ■ … φ1.78
B △ ▲ … φ1.65
C ○ ● … φ1.40
白抜き：ピン接
黒塗り：セラエグレ
ピンの接合強度 [kgf]
10.0
5.0
0.1
0.2
0.3
0.4
ズレ量 [mm]

【図１】


0.25(mm)
接合強度の最低値
ピン自身の強度
(この値でピンが切れる)
ピン強度の要求値
パッド径
□ φ1.40
△ φ1.65
◇ φ1.75
○ φ1.9
ピンの接合強度 [kgf]
メニスカス量 [mm]
10
8
6
4
2
0.1
0.2
0.3
0.4
0.5